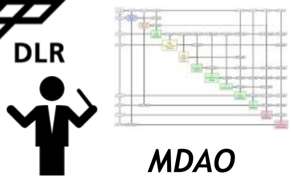
AGILE Strut-Braced Wing

BOMBARDIER
the evolution of mobility

TLAR Objectives

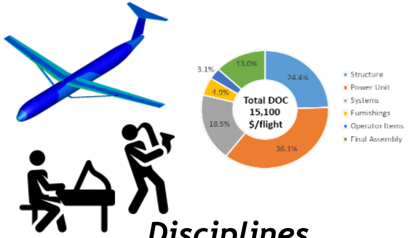
Architect

DLR



MDAO

Integrator



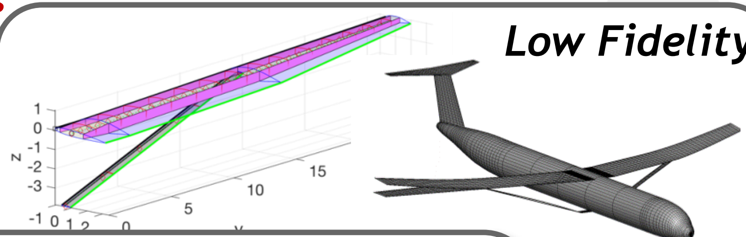
Disciplines

Specialists

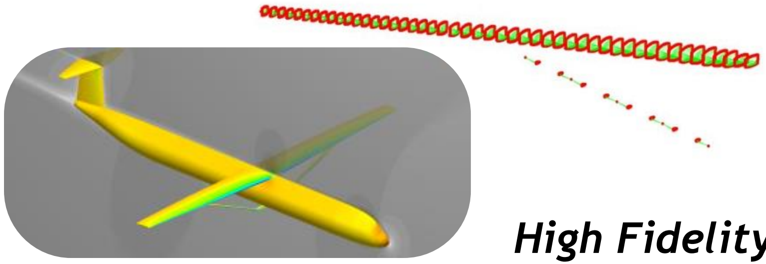
RWTH
nlr
TU Delft
POLITECNICO DI TORINO
CFS Engineering
Computational Fluids & Structures Engineering
DLR

Design Scope

Investigate the complex ***aerostructural coupling***



Low Fidelity



High Fidelity

AGILE

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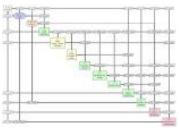
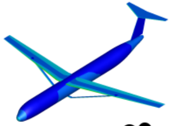
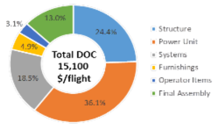


MDAO

Integrator



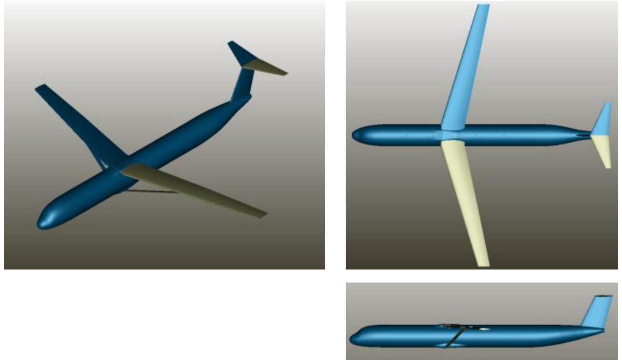


Disciplines

Specialists

Top Level Aircraft Requirements

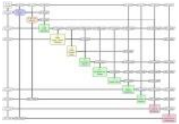
	Unit	AGILE SBW
Design Range	[km]	3500
Number of Passengers		90
Long Range Cruise Mach		0.78
Fuselage diameter	[m]	3
Fuselage length	[m]	34



AGILE Strut-Braced Wing

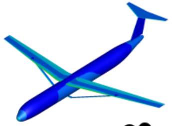
TLAR Objectives

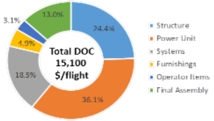
Architect



MDAO

Integrator



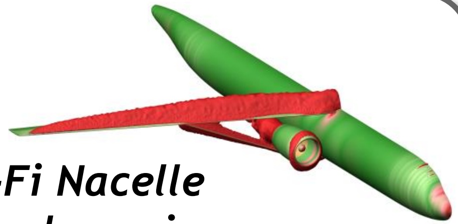


Disciplines

Specialists

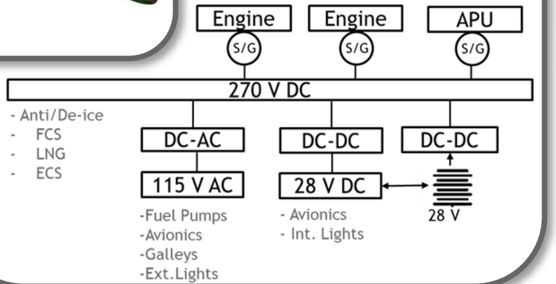
Top Level Aircraft Requirements

	Unit	AGILE SBW
Dive Mach number (Md)		0.89
Fuel reserves		5% (100 nm)
On-board systems		AEA
Engine Type		TF (under wing)



Hi-Fi Nacelle Aerodynamics

All Electric OBS Design



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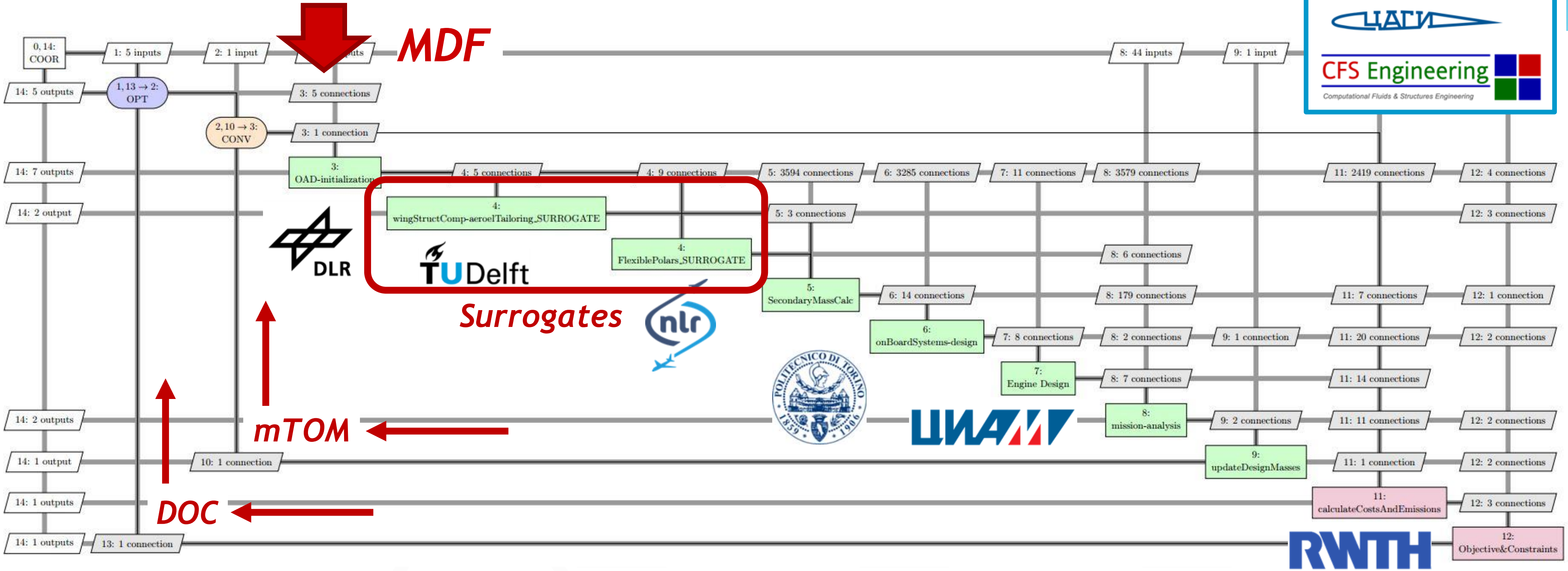
AGILE Strut-Braced Wing

BOMBARDIER
the evolution of mobility

Architect *Integrator* *Specialists*



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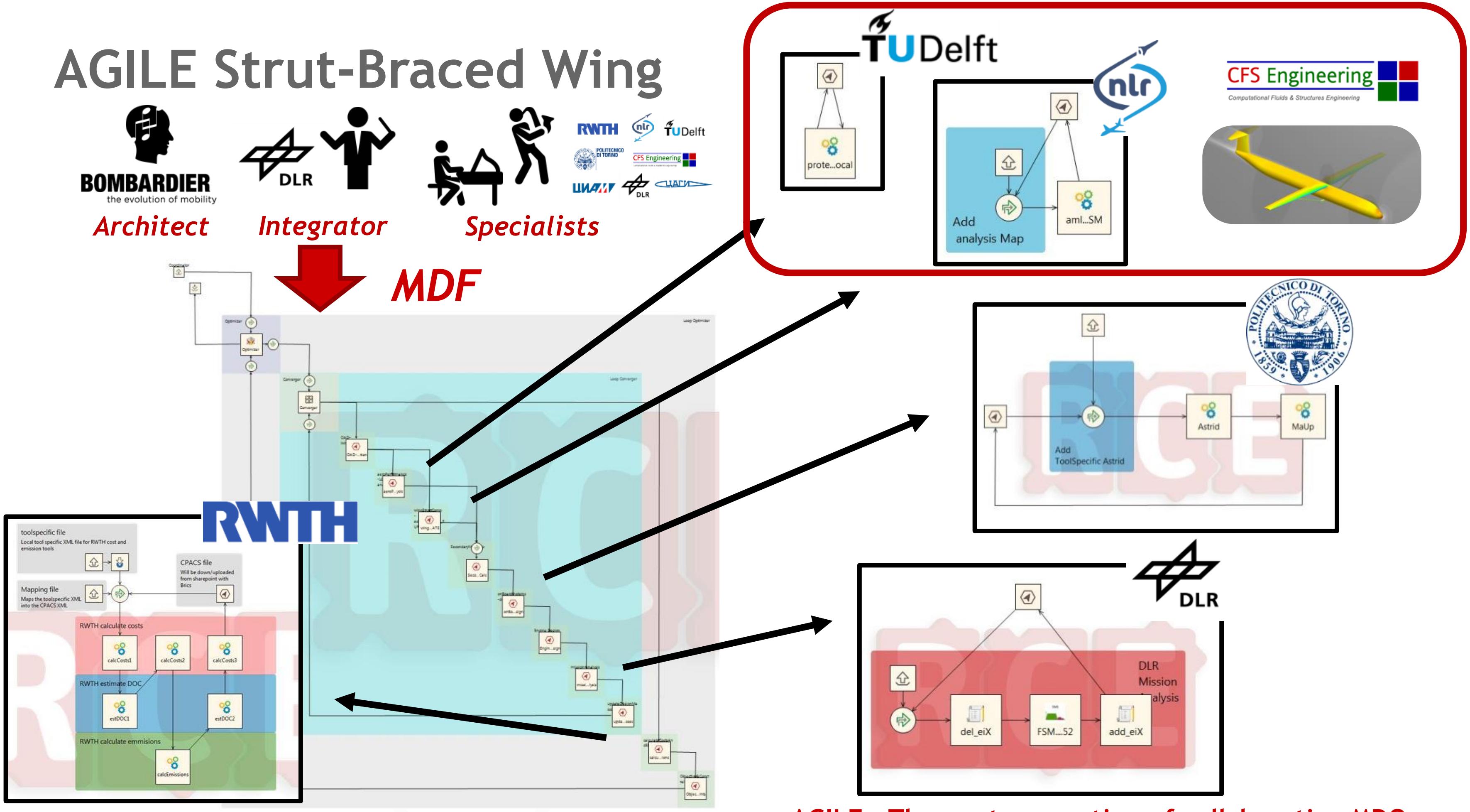
AGILE Strut-Braced Wing

Architect Integrator Specialists

MDF



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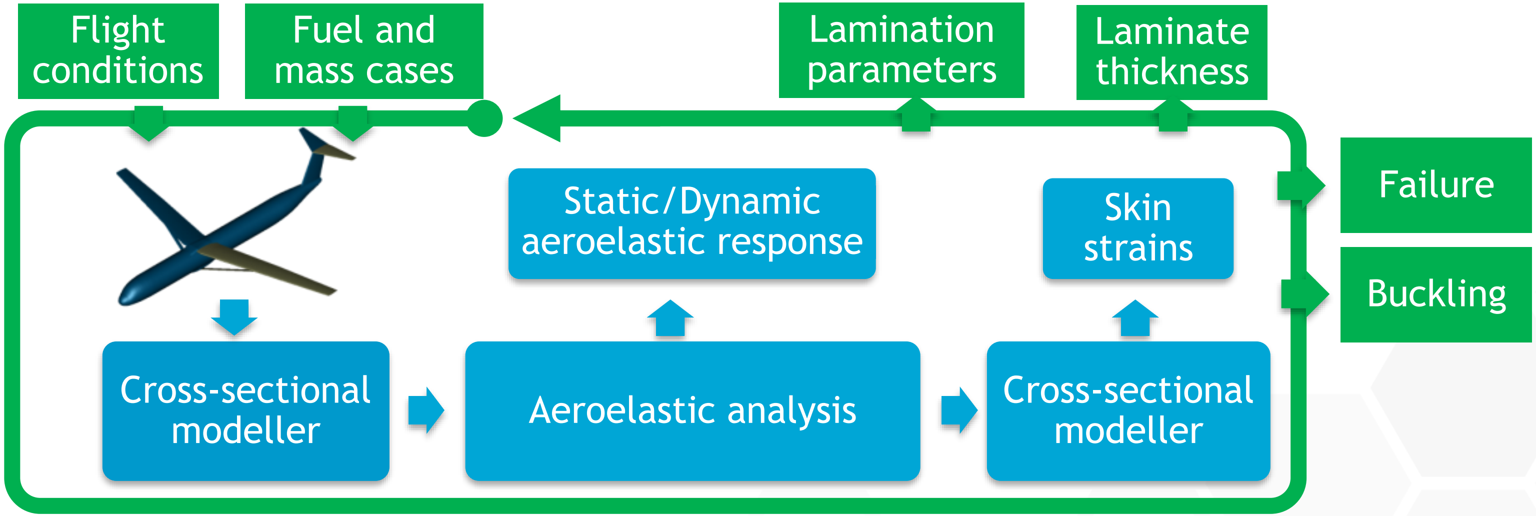
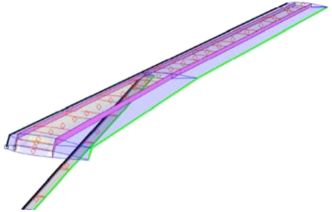
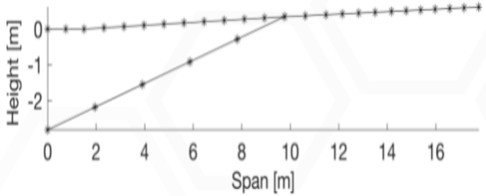
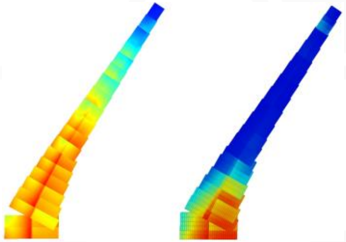
Composite Tailoring

TU Delft in house aeroelastic tool PROTEUS is used to tailor a strut braced wing.









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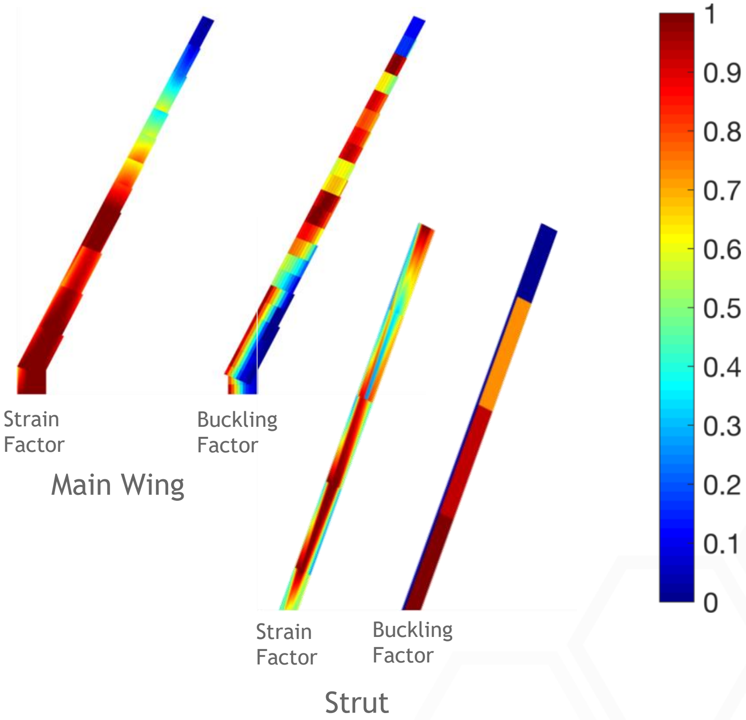
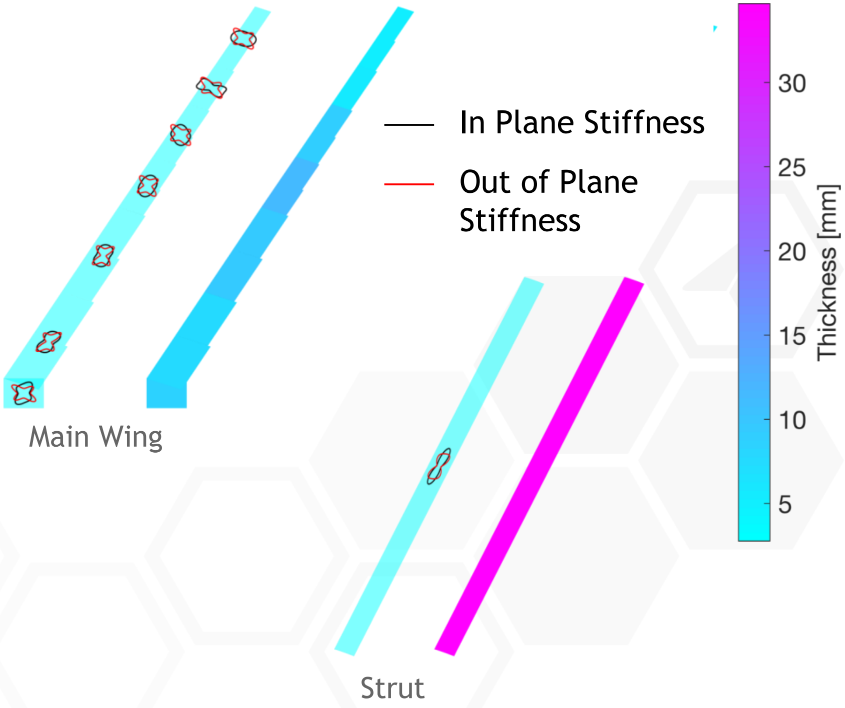
Composite Tailoring
Results Top Skin

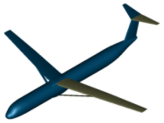




Set-up

- High Fidelity aeroelastic CFD simulations
- Multi-partner process:

DLR



CPACS to
PROTEUS

TUDelft

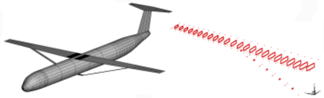
Proteus
Structural
optimization

$[K]\&\ [M]$

Stiffness + Mass
matrices

nlr

AMLoad
LowFi aeroelastic
simulations



Nastran structural
model

CPACS to
CFD model

CFS Engineering

NSMB CFD
HighFi aeroelastic
simulations

AGILE

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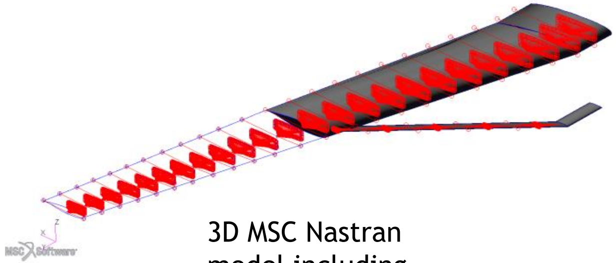
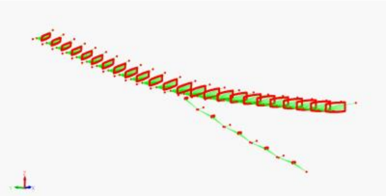
CSM - CFD coupling

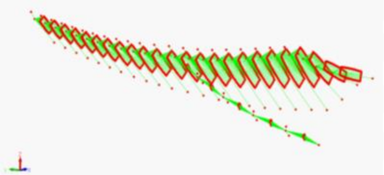
- Optimized Stiffness & Mass matrices => AMLoad => (3D) CSM model
- 3D CSM model (Nastran) => HighFi aeroelastic analyses

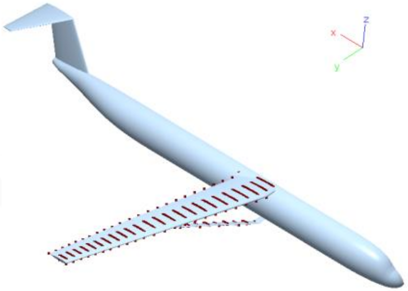


3D MSC Nastran
model including
optimized [K] & [M]



3D CSM model
1st bending mode
and torsion mode

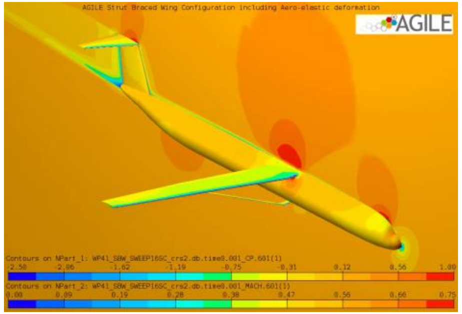




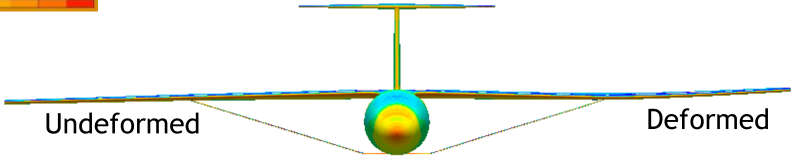
CSM model inside
CFD model

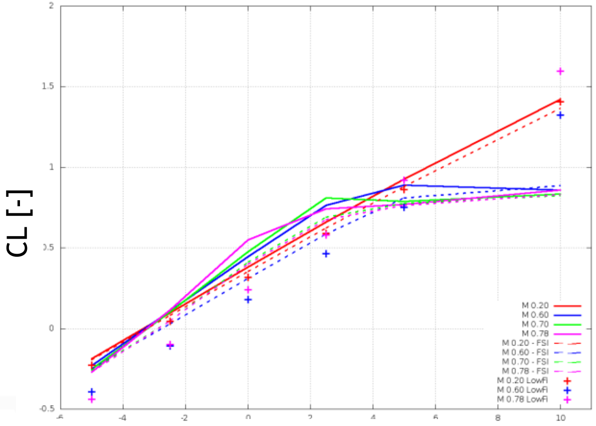
High-fidelity aeroelastic Results

- Static aeroelastic analyses for lift, drag polars
- Wingtip displacements LowFi and HighFi in agreement
- Higher M-number shock waves lead to downward twist reducing the pressure loading.



Mach 0.6
Aeroelastic deformation





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AGILE Strut-Braced Wing

Optimization - MDF Architecture

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Architect

DLR
Integrator

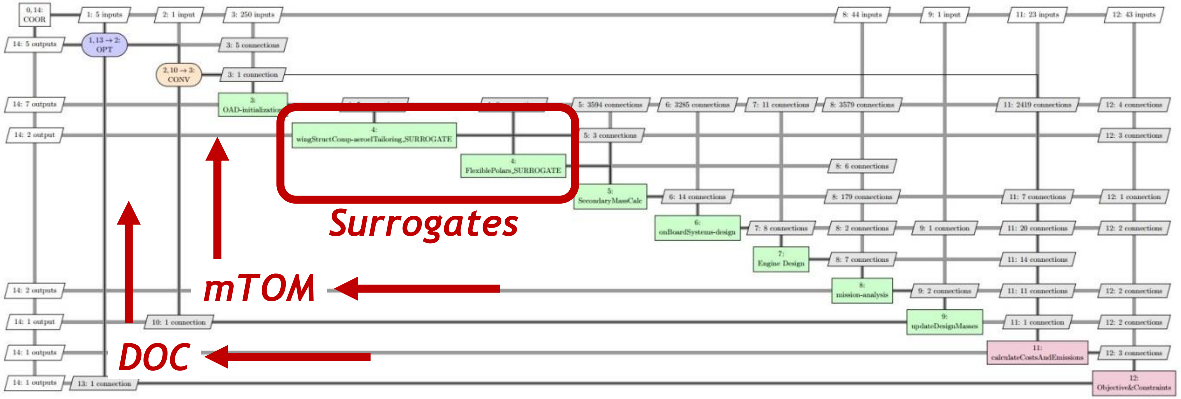
Specialists

Design Variables

- Wing span [m]
- Wing aspect ratio
- Wing sweep [°]
- Position of strut-wing connection

Constraints

- Maximum fuel
- Maximum wing loading
- Flutter constraint



Objective: ***Direct Operating Cost [USD]***

AGILE Strut-Braced Wing

Optimization - MDF Architecture

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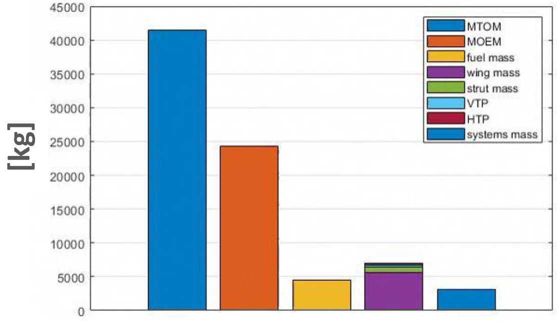
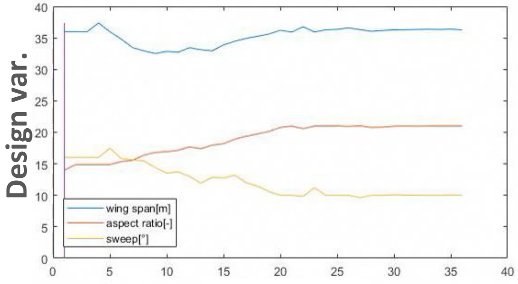
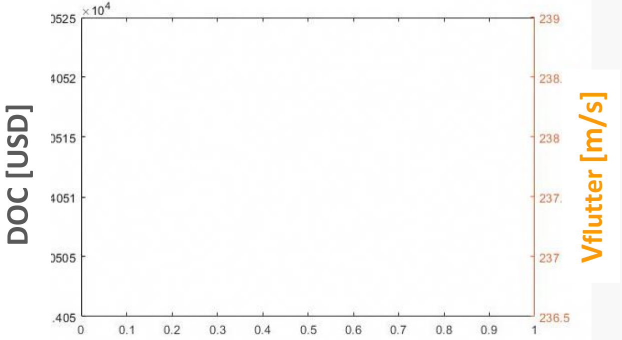
Architect · *Integrator* · *Specialists*



Mass Breakdown



Iterations



Iterations

Design Variables	Baseline	min DOC	%
Span [m]	36	33.46	
Aspect Ratio	14	15.56	
Sweep [°]	16	15.63	
Eta Strut	0.5	0.58	
OEM [kg]	24236	22693	-6%
Wing mass [kg]	5612	4544	-19%
Strut mass [kg]	888	786	-11%
mTOM [kg]	41403	39300	-5%
Block Fuel [kg]	5681	5121	-10%
DOC [USD]	14051	13330	-5%

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